



2010 Insensitive Munitions & Energetic Materials Technology Symposium

Shaped Charge Jet Initiation of High Explosives equipped with an Explosive Train

Werner Arnold, Markus Graswald

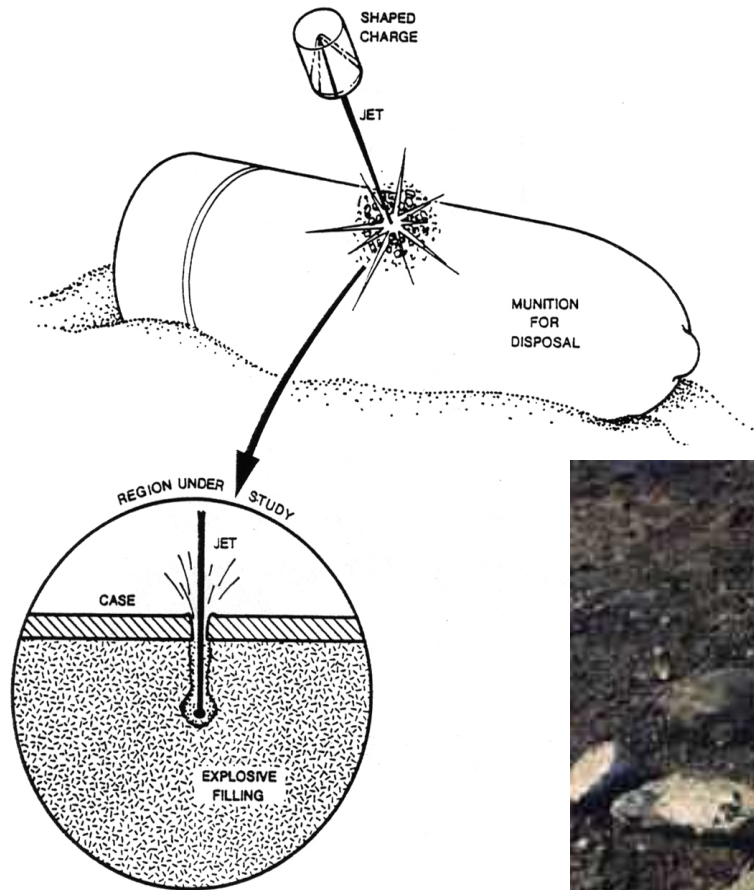
TDW - Gesellschaft für verteidigungstechnische Wirksysteme mbH
Schrobenhausen, Germany

München Marriott Hotel, Munich, Germany
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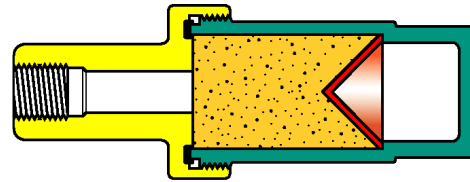
- **Motivation**
- **Background & Basic Investigations**
- **SCJ Initiation under Varying Impact Angles**
- **SCJ Initiation with an Explosive Train (ET)**
- **Conclusions**

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Explosive Ordnance Disposal (EOD) with Shaped Charge



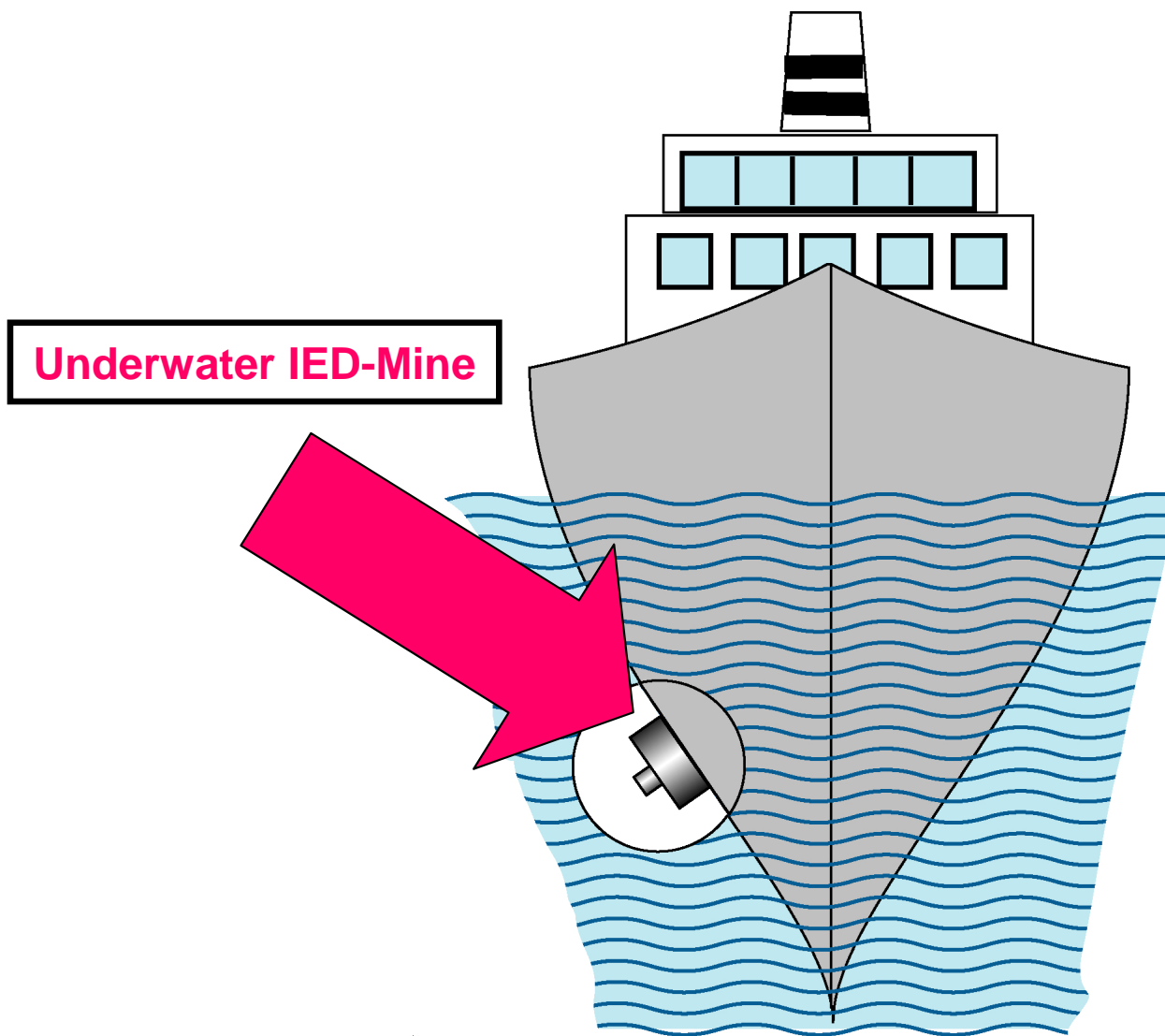
EOD Shaped Charge



Countering of RAM Mmunition (Rockets, Artillery Shells, Mortar Grenades)

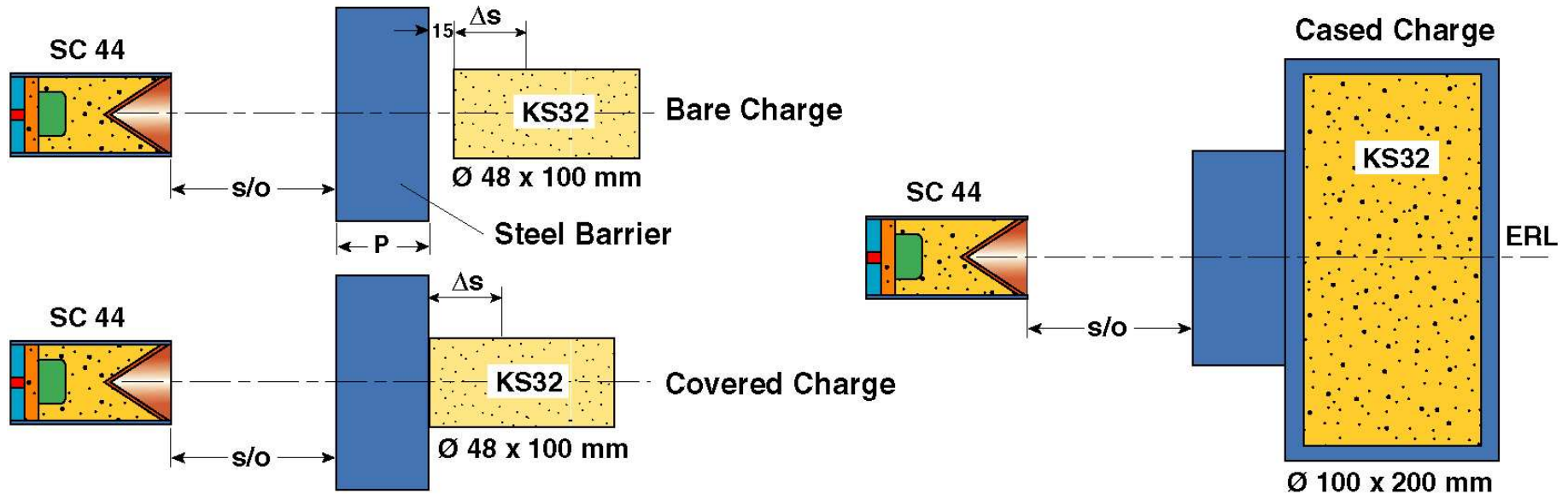


Countering of Underwater IED-Mines (Improvised Explosive Device)



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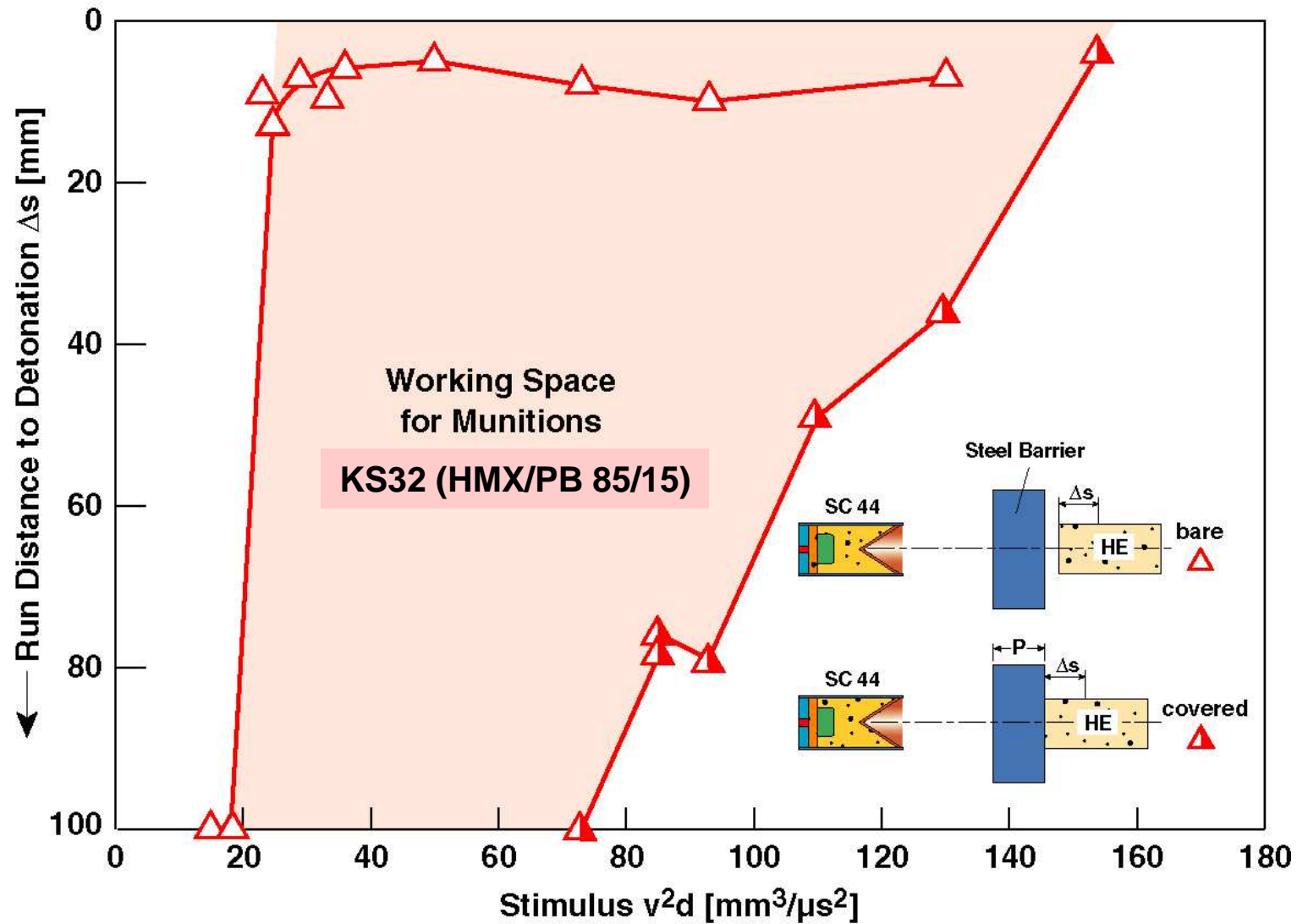
Basic Investigations with *Bare vs Covered and Cased Charges*



IMEMTS 07, Miami, USA: “Sensitivity of High Explosives Against Shaped Charge Jets”

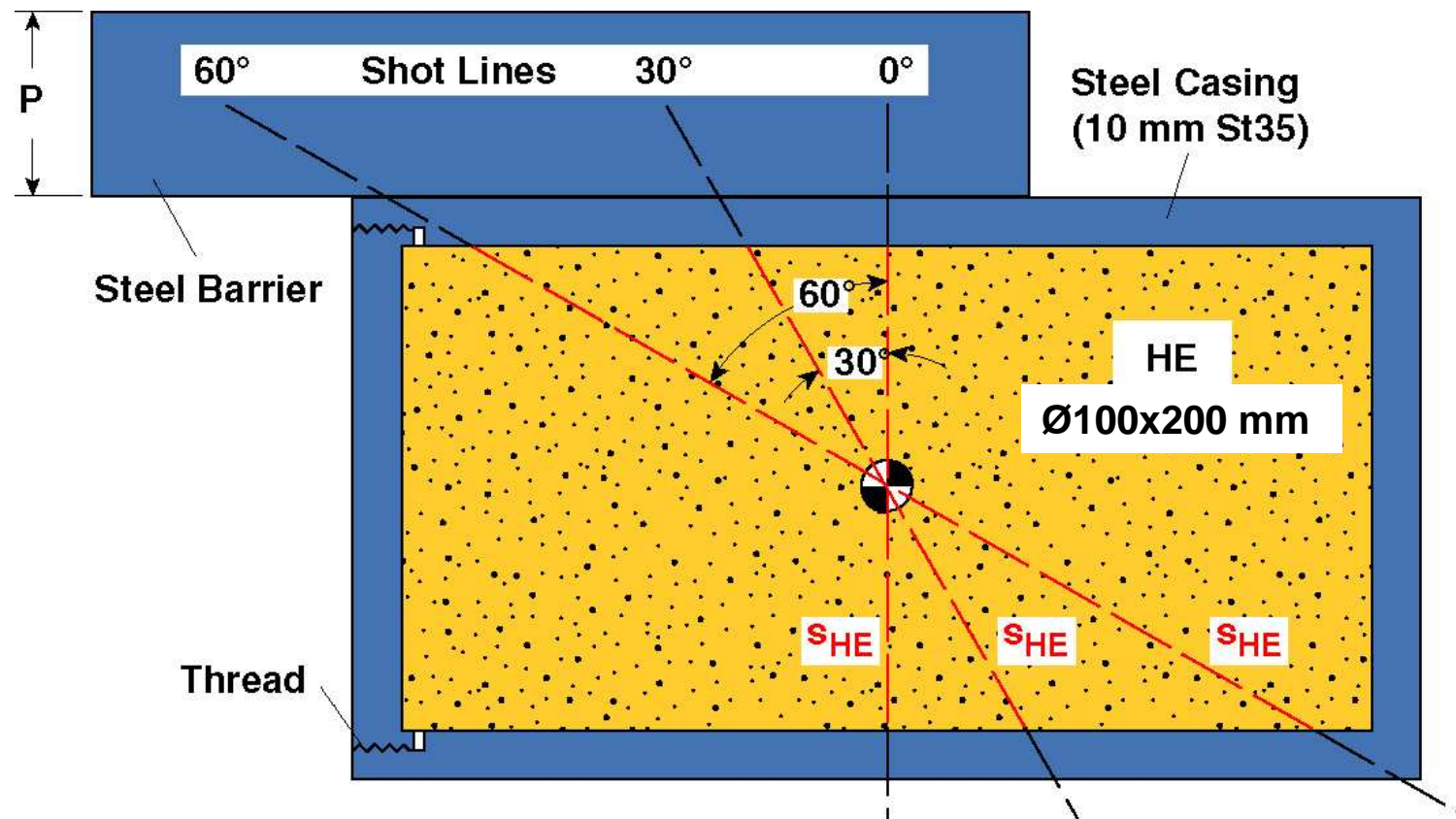
HVIS 10, Freiburg, Ge: “High Explosive Initiation by High Velocity Projectile Impact”

SCJ Initiation Behaviour with *bare* & *covered* Setups



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SCJ Initiation Trials with Varying Impact Angles: 0°, 30°, 60°



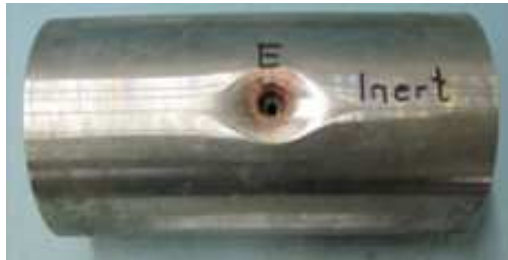
$S_{HE}(0^\circ) = 100 \text{ mm}$
 $S_{HE}(30^\circ) = 115 \text{ mm}$
 $S_{HE}(60^\circ) = 200 \text{ mm}$

Jacobs-Roslund Formula: Increasing Impact Angle θ

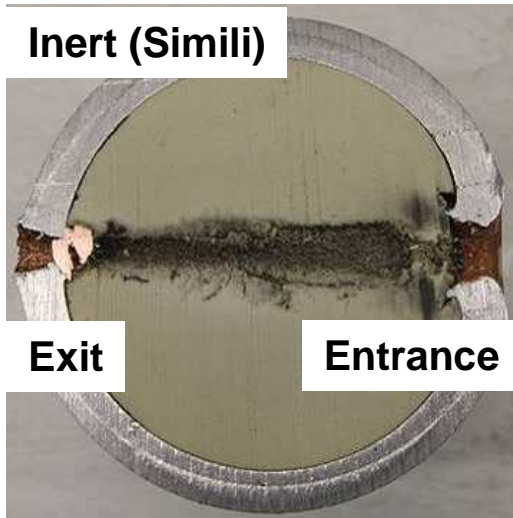
$$v_{crit} = \frac{A}{\sqrt{D_p \cdot \cos \theta}} \cdot (1 + B) \cdot \left(1 + \frac{C \cdot t}{D_p} \right)$$

 $v_{crit}^2 D_p \sim 1 / \cos \theta$

Explosive Reaction Level (ERL) Assessment (MIL-STD 2105C)



Inert (Simili)



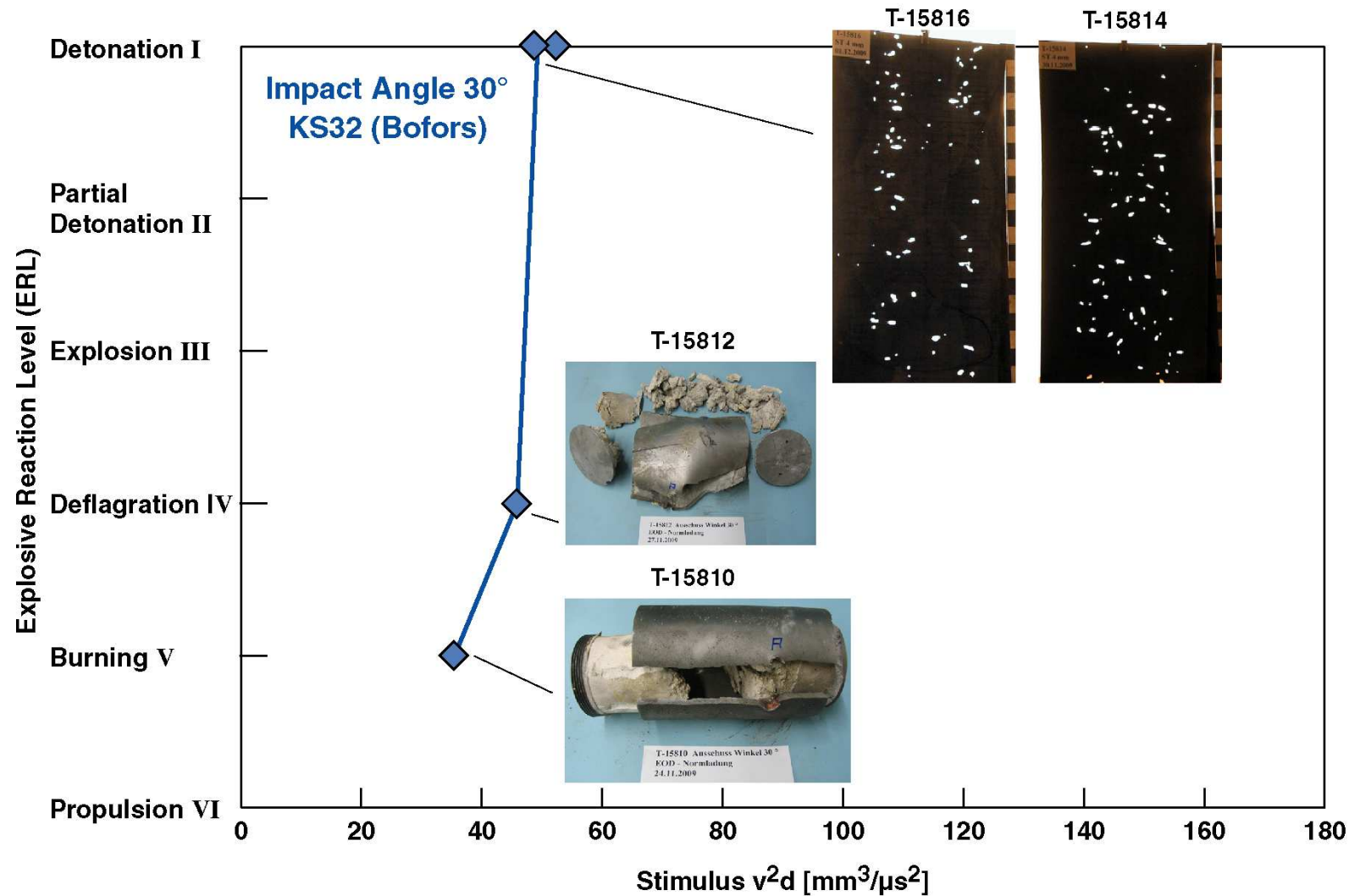
T-15810 Ausschuss Winkel 30°
EOD - Normladung
24.11.2009



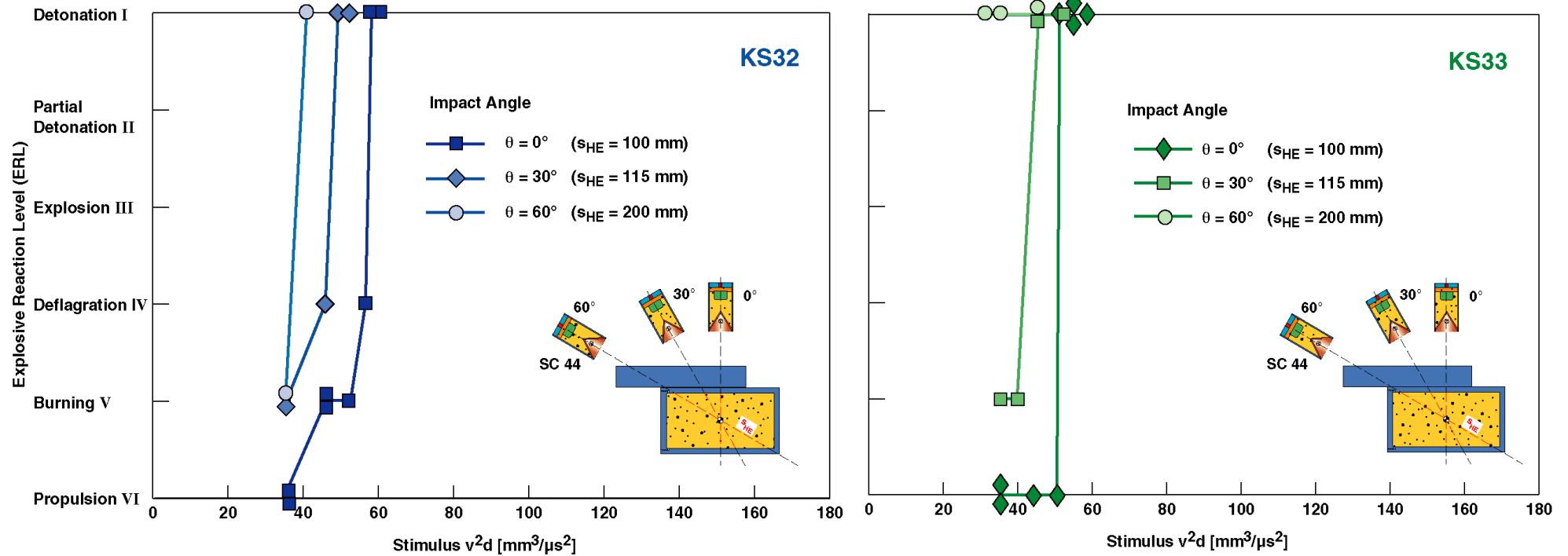
T-15829 Einschuss Winkel 90°
EOD - Normladung
21.12.2009



Results for KS32 (HMX/PB 85/15): ERL vs SCJ Stimulus

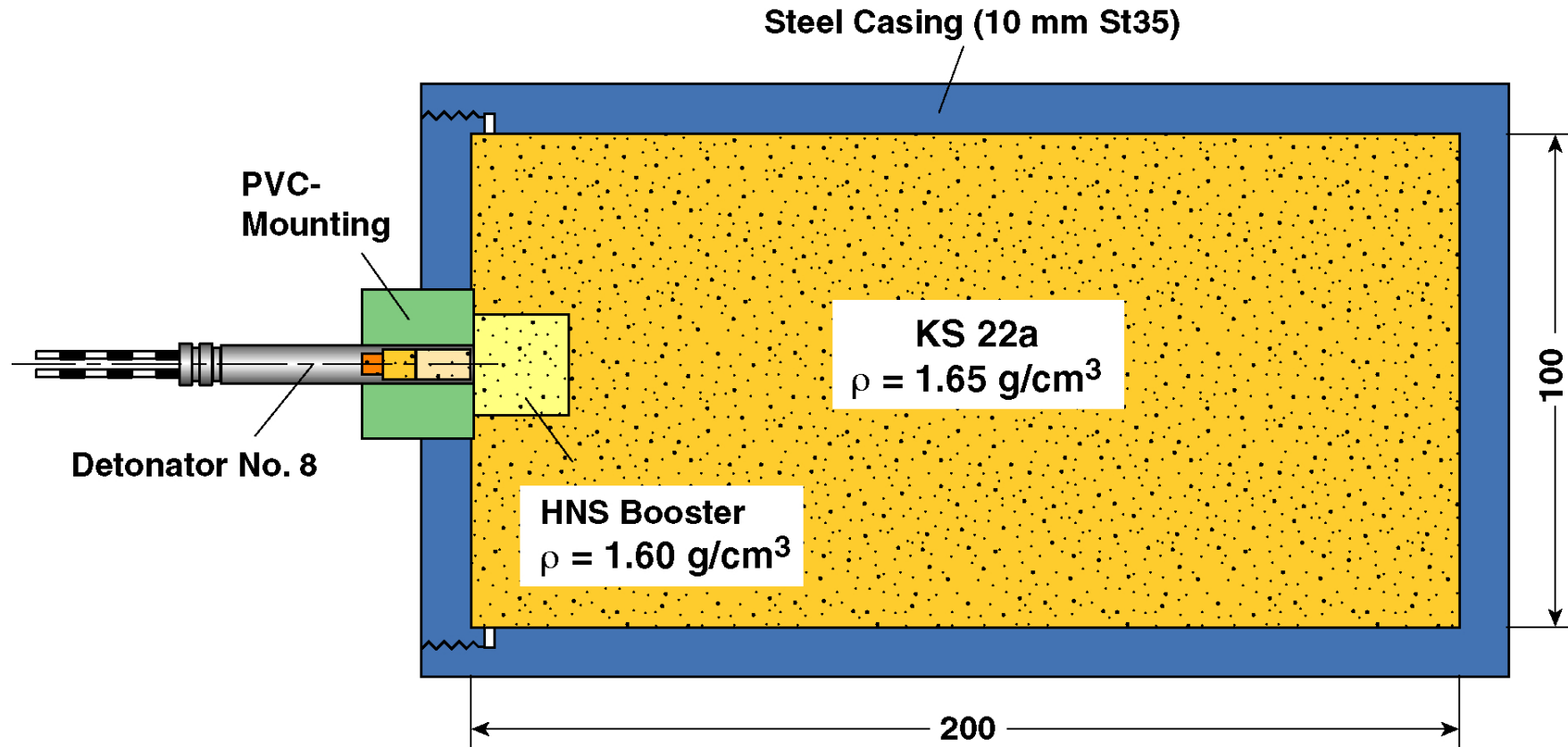


Summary for **KS32 (HMX/PB 85/15)** & **KS33 (HMX/PB 90/10)**

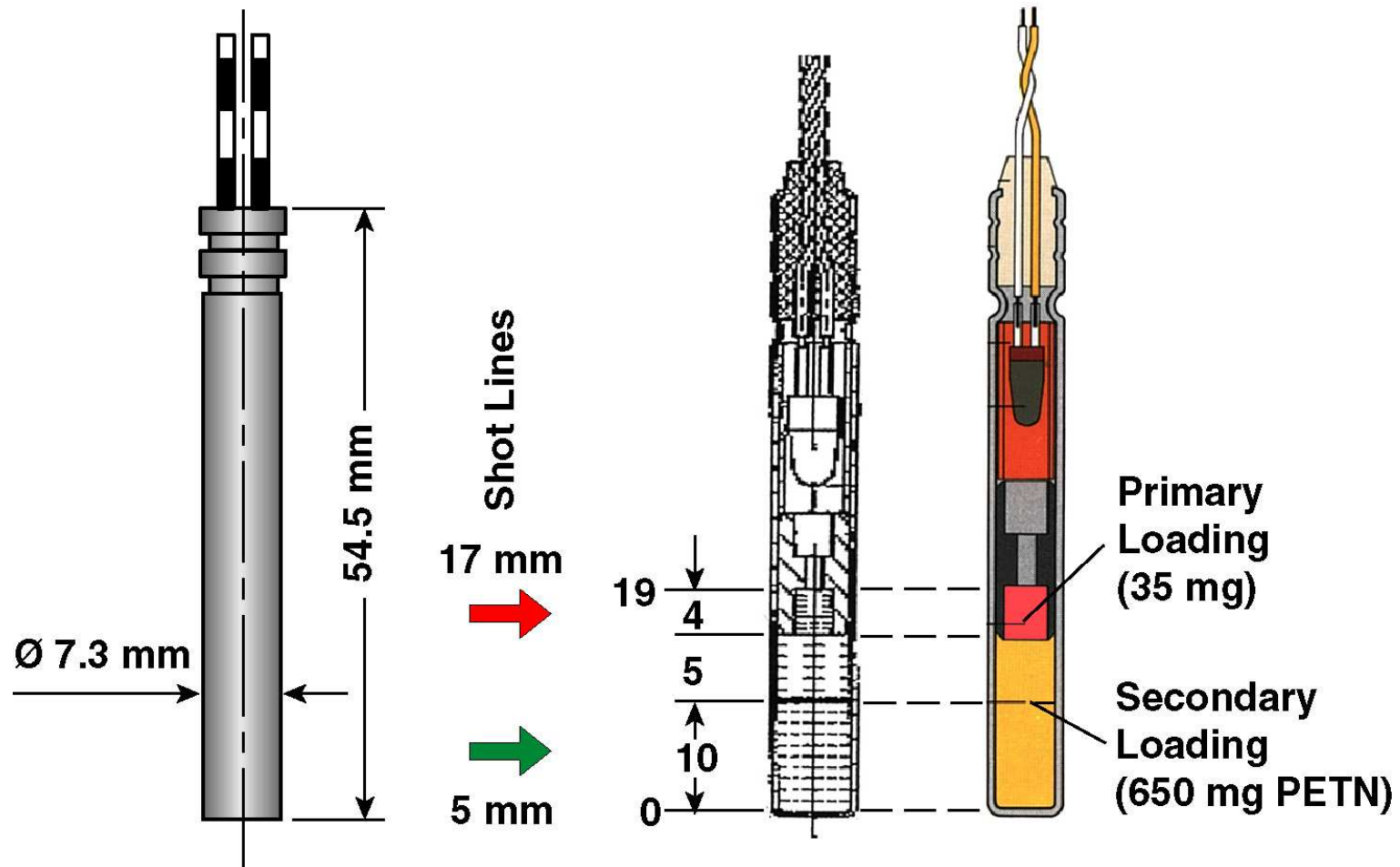


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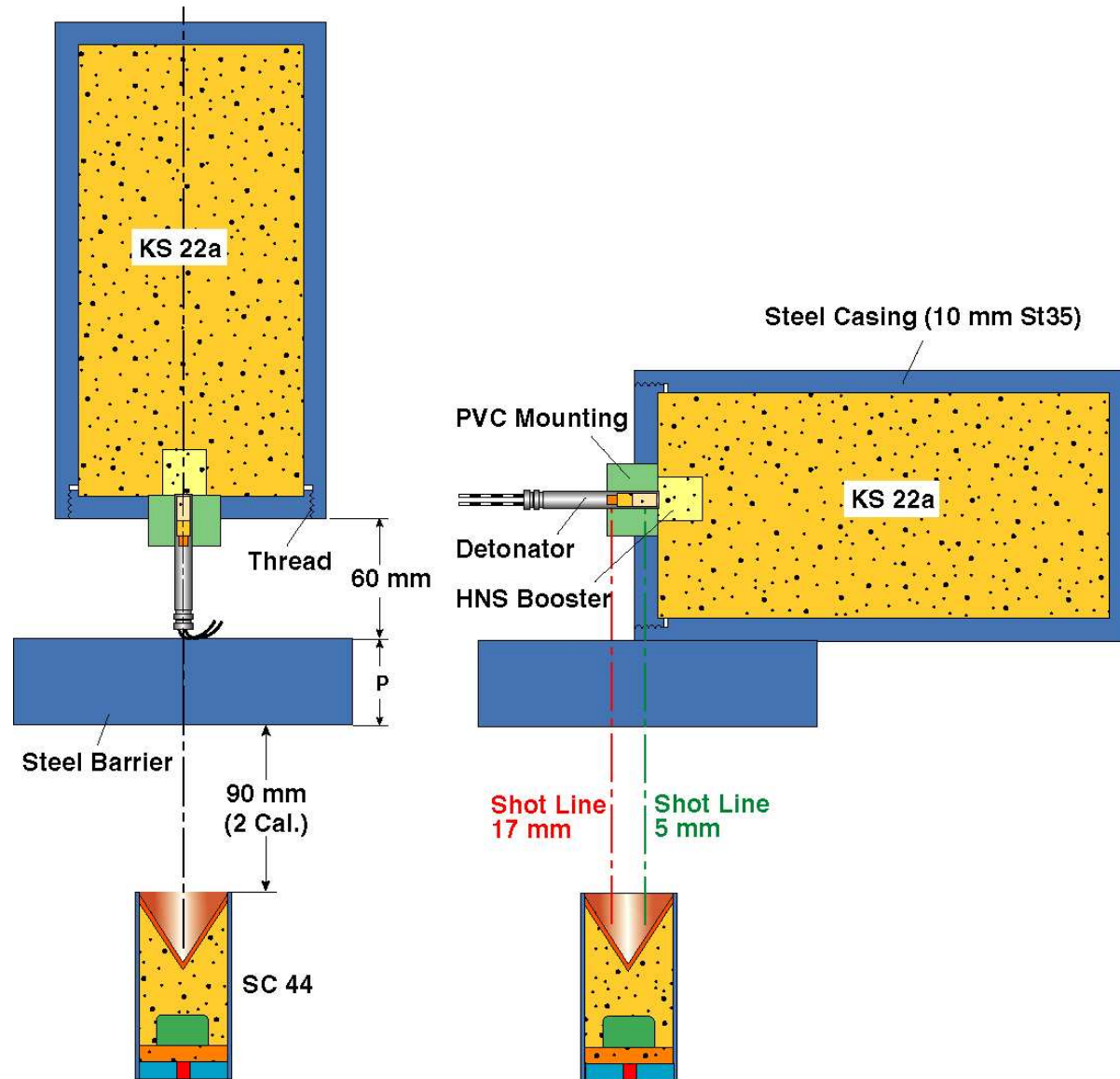
Generic Test Charge with Explosive Train (Detonator & Booster)



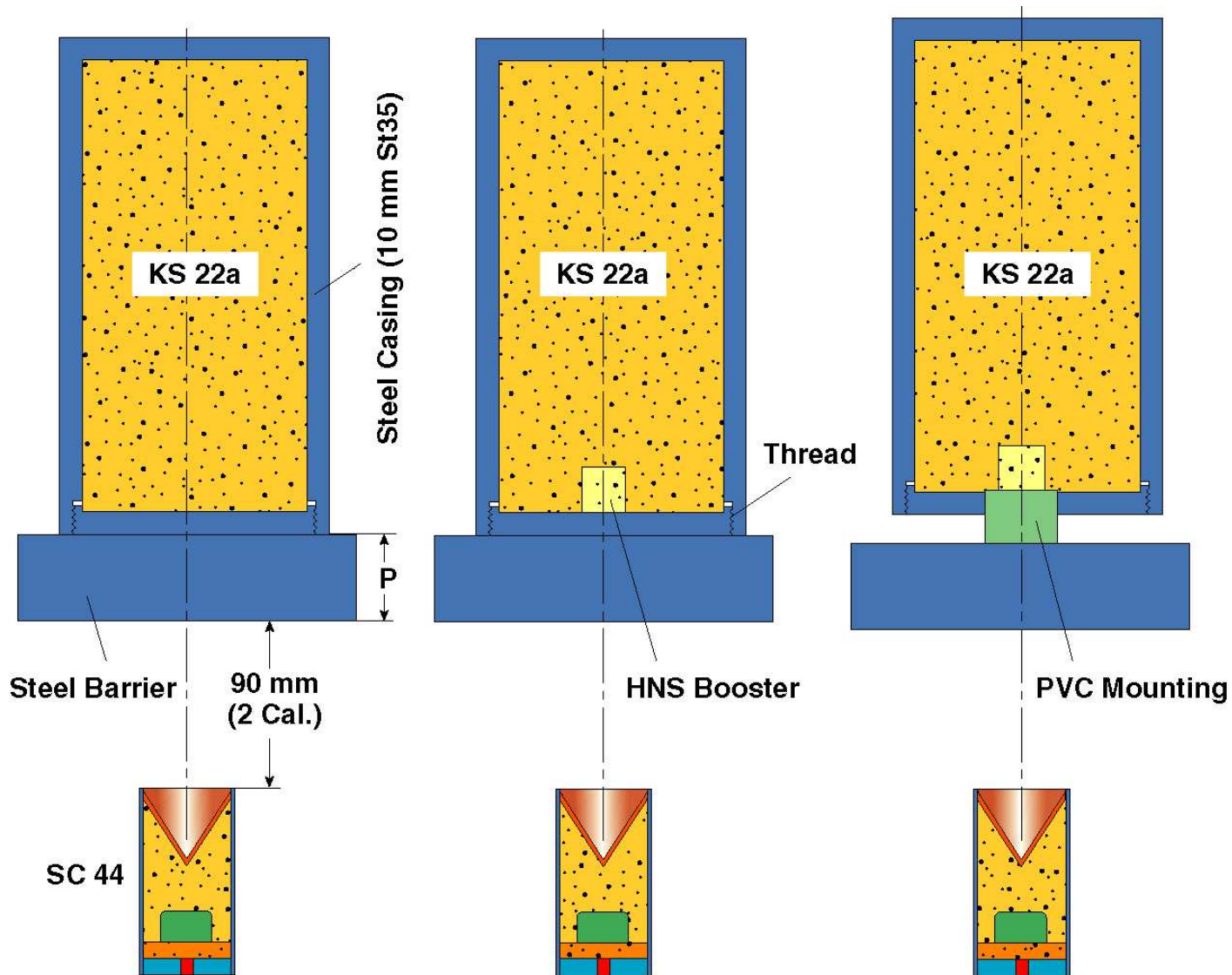
Detonator No. 8: Dimensions & Primary / Secondary HE Loading



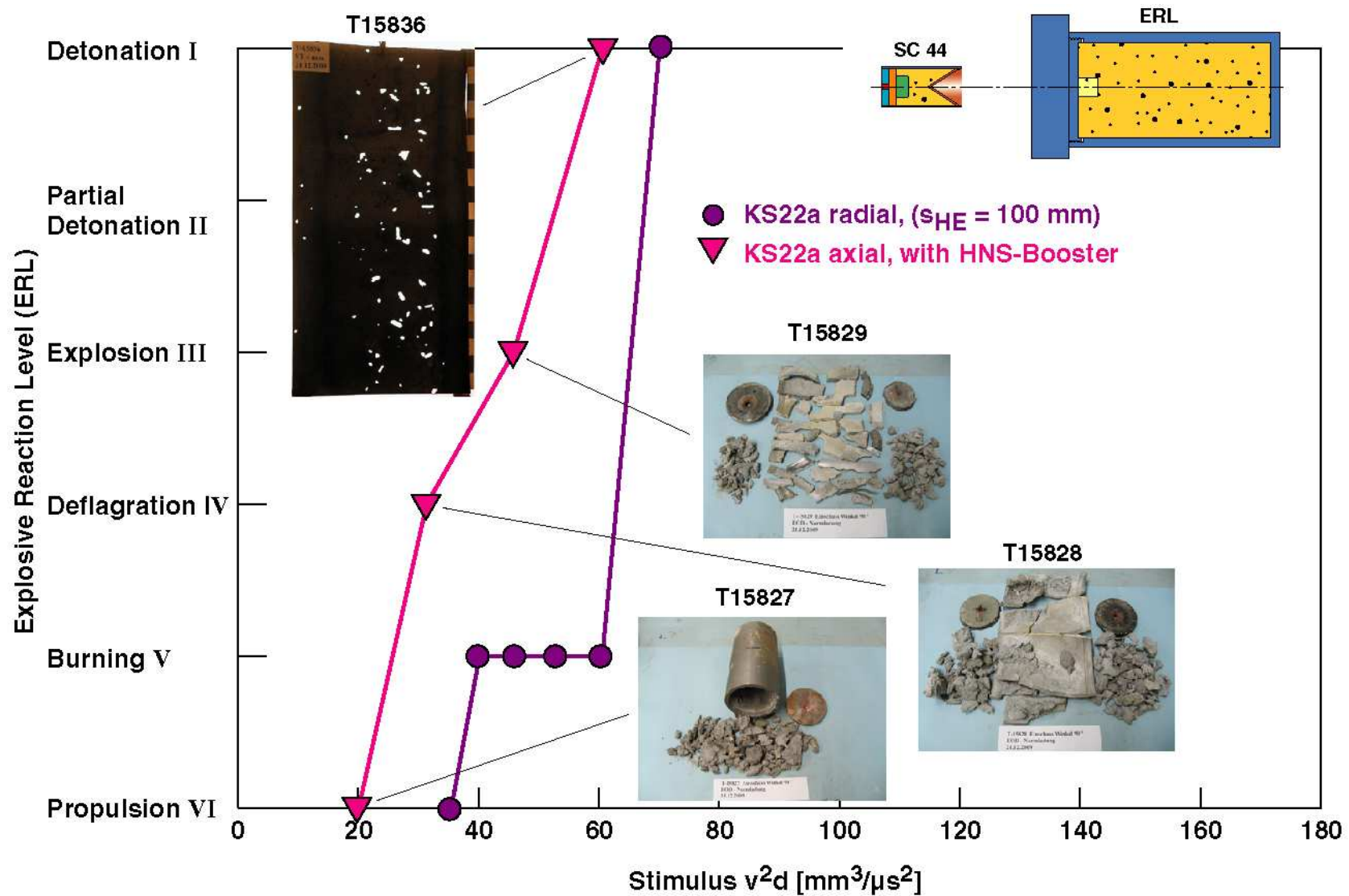
SCJ Initiation Trials with Explosive Train: Impact Angles: 0°, 90°



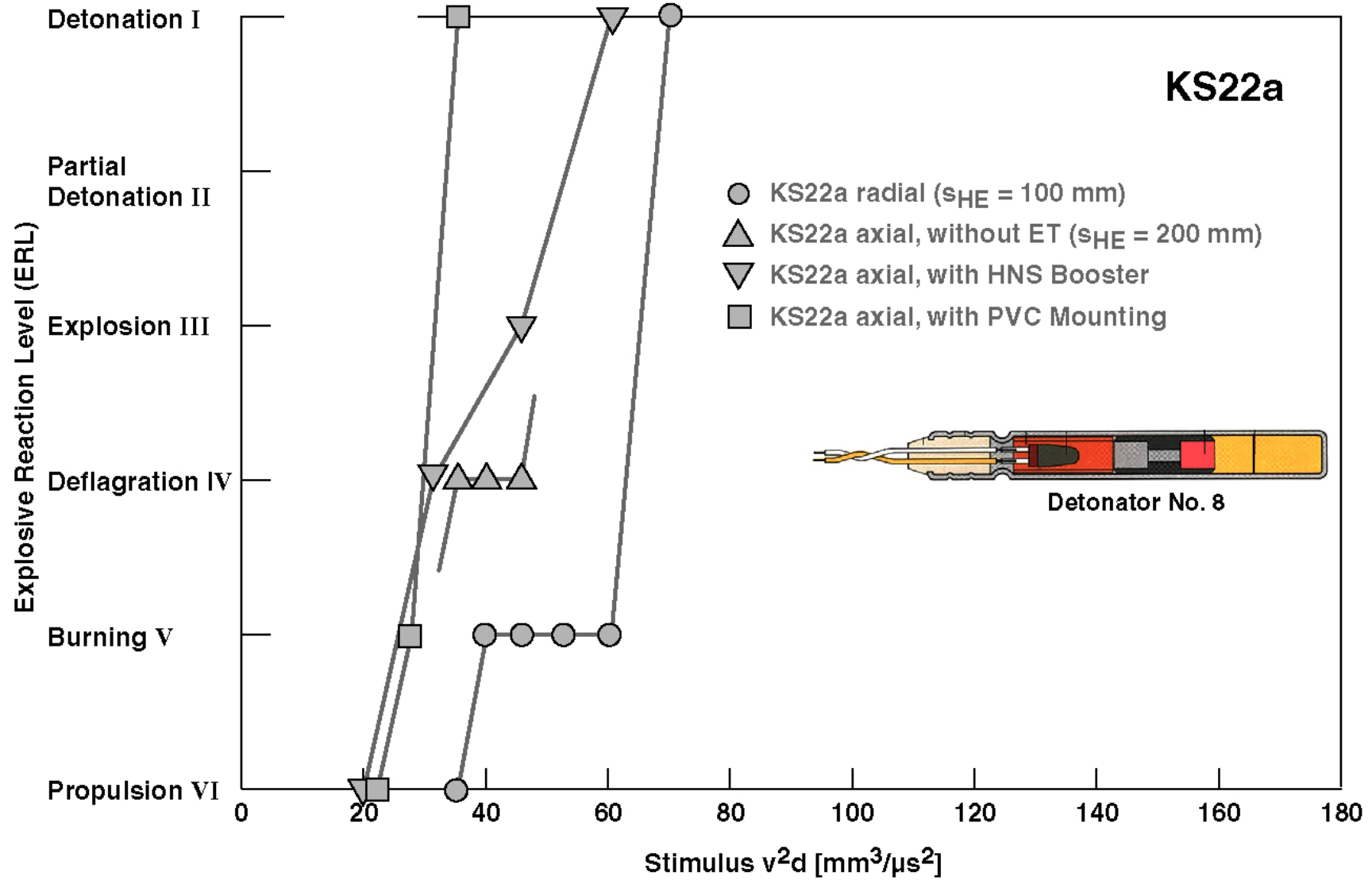
Step-to-Step Procedure: 3 different generic Charges



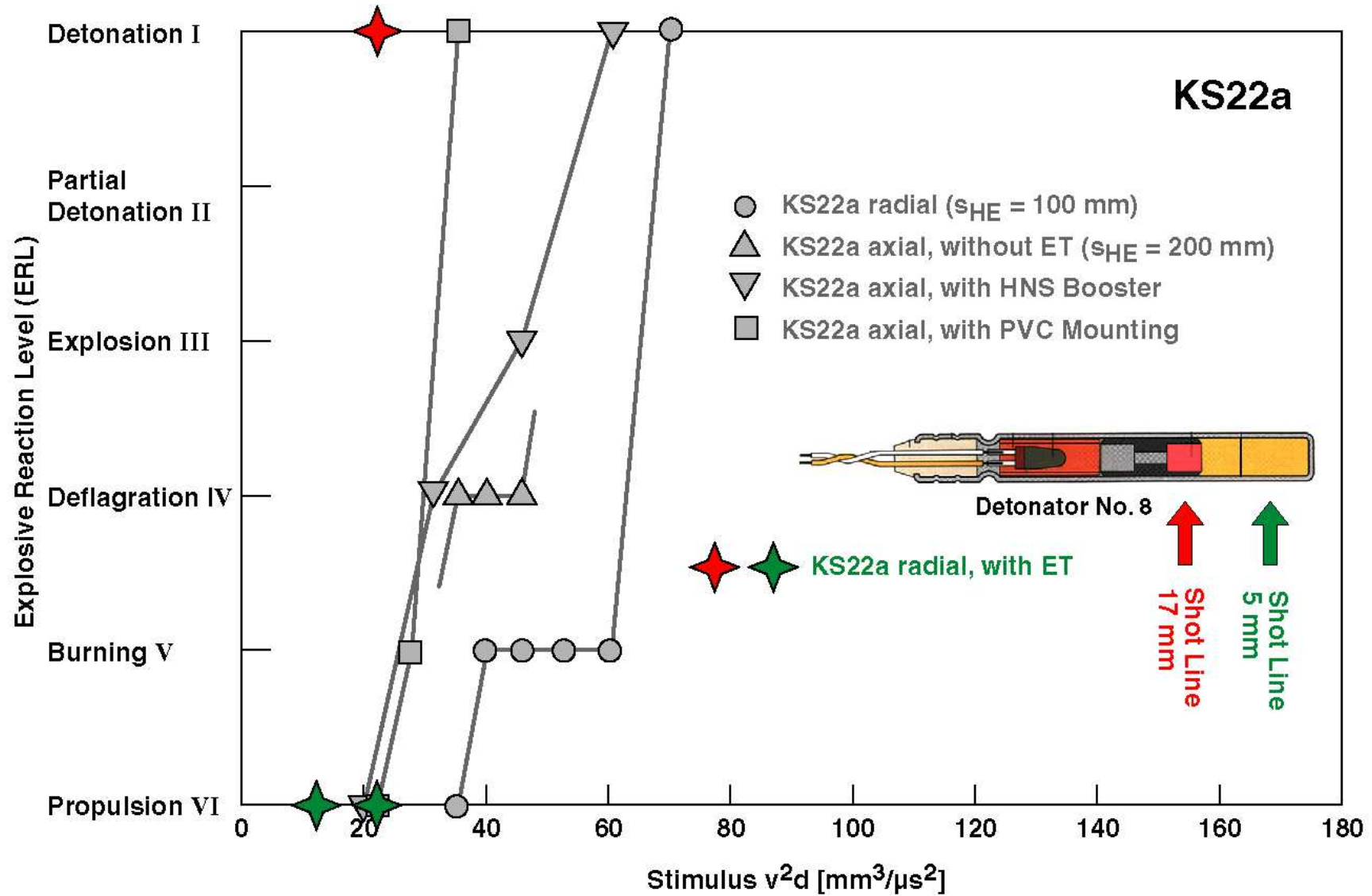
ERL Results: HNS Boosted Charge compared to KS22a radial



Summary ERL Results: ET axial



Summary ERL Results: ET radial



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Conclusions: Impact Angle

- **SCJ Initiation Trials under varying Impact Angles: 0°, 30°, 60°**
- **Charge: PBXs (KS32 & KS33) with 85% & 90% HMX and PB**
- **We found Reduced Stimuli with Increasing Angle (Interaction Length)**
- **Models (like Jacobs-Roslund) don't consider Charge Length**

Conclusions: Explosive Train

- **SCJ Initiation Trials with an Explosive Train (Impact Angles 0° & 90°)**
- **Charge: PBX (KS22a) with 67% RDX and a HNS Booster**
- **Detonator No 8 with Primary & Secondary (650 mg) HE Loading**
- **Result: it is possible to neutralize a Charge via its Explosive Train**

Thank You for Your Attention !

Any Questions ?

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